MENDEL'S LAW OF DICHOTOMY IN HYBRIDS.

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In the study of hybrids we must, as De Vries (1900b) truly says, no longer pay primary attention to the degree of difference between the forms united — to whether they are species, subspecies, or varieties — but to the behavior of the peculiar characters by which the crossed individuals and their ancestors are distinguishable. For each of these somatic characters corresponds to some peculiarity of the germplasm. The behavior of the differing characters when united in the hybrid is diverse; three categories have long been recognized (Galton, 1888, p. 12). These are: (1) *blending* heritage, illustrated by skin color in man; (2) *alternative* heritage, illustrated by human eye color; and (3) *mixed* heritage, illustrated by the piebald condition of the progeny of mice of different colors. The law of dichotomy in hybrids applies only to the second class, — alternative heritage, — although it has recently been brought forward by De Vries (1900) as the almost universal law of inheritance in hybrids. The law itself was first enunciated very clearly and completely by Mendel (1865) and deserves to bear his name. The law was, however, forgotten. It has been rediscovered independently by De Vries and by Correns (1900), both of whom are able to add new evidence of its validity (for *alternative* heritage!).

In his illustration of Mendel's law, De Vries first classifies hybrids into monohybrids, dihybrids, and polyhybrids, according as their parents differed in one character only, or in two characters, or in many characters. The case of inheritance in monohybrids is the simplest, and will be first considered. Mendel's and De Vries's investigations have established the following principles:

1. Of the two antagonistic peculiarities the hybrid exhibits only one; and it exhibits it completely, so as not to be

distinguishable in this regard from one of the parents. Intermediate conditions do not occur [in *alternative* heritage].

2. In the formation of the pollen and the egg cell the two antagonistic peculiarities are segregated; so that each ripe germ cell carries either one of these peculiarities.

Of the two antagonistic peculiarities united in the hybrid, that which becomes visible in the soma is called by Mendel the *dominating;* that which lies latent is called the *recessive* character. What determines which character shall be dominating is still unknown, and the determination of this point offers an enticing field of inquiry. In some cases the dominating form is the systematically *higher;* in others it is the older or ancestral form.

The law of dichotomy may now be developed. When a hybrid (monohybrid) fertilization takes place the zygote contains both the dominant quality (abbreviated *d*) and the recessive quality (*r*). In the early cleavages *d* and *r* are both passed over into both the daughter-cells; but apparently, at the time of segregation of the germ cells, the somatic cells are provided with *d* only, while the germ cells retain both qualities. In the ripening of these germ cells, probably in the reduction division, *d* and *r* come to reside in distinct cells, so that we have

of the female cells 50% *d* + 50% *r*, and
of the male cells 50% *d* + 50% *r*.

If now hybrids are crossed haphazard, a male *d* cell may unite with either a female *d* cell or with a female *r* cell; likewise a male *r* cell may unite with a female *d* or a female *r* cell. Consequently in the long run we shall have of all the zygotes

$$25\%\ d,d + 50\%\ d,r + 25\%\ r,r,$$

or 50% of the zygotes hybrid and 50% of pure blood, and of the latter half exclusively maternal and half paternal. But since the soma developed from the hybrid germ cell has the dominant character, we shall have

75% of the cases with the dominant character
25% " " " " " recessive "

and this agrees with various empirical results, of which the following from Correns is instructive. A cross was obtained

between a species of pea with a green (*g*) germ and one having a yellow (*y*) germ. Yellow is dominating.

Gen. 1.	31 *y* (hybrid) peas; produced 12 plants; these bore:	
Gen. 2.	775 *y* (hybrid + *y*) peas (= 75.8%). 21 plants were produced.	247 *g* (pure-blooded) peas (= 24.2%).
	7 (33%) pure-blooded *y*, because they bore:	14 (66%) hybrids, because they bore: — 20 plants bore:
Gen. 3.	292 *y* peas.	462 *y* (hybrid + *y*) peas (= 76.4%). — 149 *g* (pure-blooded) peas (= 23.6%). — 670 green peas.

It is clear that if this process of crossing of the hybrids continues, the *proportion* of hybrids to the whole population will diminish; for the share of pure-blooded forms breeds true; while the originally equal share of hybrids is repeatedly halved.

If the hybrid is crossed with one of the parents instead of with another hybrid, we will

$$\text{get } (d + r)\ d = d, d + d, r, \text{ and}$$
$$(d + r)\ r = d, r + r, r.$$

In the first case all of the progeny will appear of the dominant type. In the second case one-half will appear of that type. This again agrees with experiment.

In the case of dihybrids the law of alternative heritage is somewhat more complicated. Imagine a lot of ripe germ cells with the antagonistic qualities of any pair separated according to the second principle stated at the outset. *A* indicates the one pair of qualities and *B* the other; then we shall have nine classes of zygotes, the proportion of each of which is as follows:

A. 25% *d, d* — 50% *d, r*

B. 6.25% *d, d*; 12.5% *d, r*; 6.25% *r, r*. — 12.5% *d, d*; 25% *d, r*; 12.5% *r, r*.

A. 25% *r, r*

B. 6.25% *d, d*; 12.5% *d, r*; 6.25% *r, r*.

Thus the first class has 6.25% purely dominant in both characters; the second class, 12.5% purely dominant in one character and hybrid in the other, and so on. Recalling that hybrid zygotes produce somas with the dominant character, it follows that the progeny appear as follows:

A. dom. + *B*. rec.	18.75%
A. rec. + *B*. dom.	18.75%
A. dom. + *B*. dom.	56.25%
A. rec. + *B*. rec.	6.25%

A result which again agrees with experiment. The resulting mixtures of characters in tri to polyhybrids may be likewise predicted, by extending the principles already laid down.

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